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~~WDM RING NETWORK~~

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~~Description~~

5 In a ring network with predominantly one-way data transport, ~~such as e.g.~~ in the case of data transport within the Internet or in the case of video distribution services, data ^{is} ~~are~~ transmitted from a central network element, e.g. an internet server, toward the subscriber. In the case of ^{the} ~~this~~ ring network utilization mentioned at the beginning, only very limited data transport takes place from a subscriber to the central network element.

15 However, conventional transmission methods in the synchronous digital hierarchy provide the same transmission capacity in the transmission direction, ^{both and from} to the subscriber and ~~from the subscriber~~. Highly pronounced one-way data transport entails the disadvantage that almost half of the transmission capacity of the ring network remains unutilized.

20 The ^{present} invention is, ^{therefore, directed to} ~~based on the object of~~ specifying a circuit arrangement and a method with which the transmission capacity of a ring network with predominantly one-way data transport can be used.

25 ~~According to the invention, the object set is achieved by means of patent claims 1 and 5.~~

^{present} The invention entails the advantage that the transmission capacity with predominantly one-way data transport on the ring network is utilized, with transmission reliability remaining the same.

30 The ^{present} invention entails the advantage that data transport from the subscriber to the central network element of the ring is also possible.

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Further advantageous designs of the circuit arrangement and of the method are specified in the rest of the patent claims.

Further special features of the invention will become apparent from the following more detailed explanations of an exemplary embodiment with reference to drawings.

In the figures:

Figure 1 shows a construction and the data transport paths of a conventional ring network;

Figure 2 shows a construction and the data transport paths of a ring network according to the teachings of the Present invention;

Figure 3 shows a configuration of a central network element;

Figure 4 shows a configuration of a network element,

Figure 5 shows a configuration of network elements which respectively terminate one half of the ring network; and

Figure 6 shows a further configuration of network elements which respectively terminate one half of the ring network.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the synchronous digital hierarchy SDH, use is preferably made of ring structures in which individual network elements for coupling out or coupling in data are integrated. The ring structure enables the transmission of data which, if they are transmitted directly to the subscriber, are designated as working signals. Owing to the high degree of data protection demanded, the data to be transmitted to the subscriber, ^{is} ~~are~~ also transmitted as protection signals on a second transmission path within the ring to the subscriber. This type of data transmission ensures a high degree of transmission reliability in the event of an interruption of the ring.

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The^{Present} invention's method with associated circuit configuration will be explained in more detail using a ring structure with synchronous transfer mode STM data transmission.

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First of all, in

of the present invention

In order to provide a better understanding, ~~first of~~ all data transport directed one-way will be assumed, in which no data transport takes place from a subscriber to the central network element.

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Figure 1 illustrates a ~~realization according to~~ ring network which is known: in the prior art. In this figure, a central network element A and a multiplicity of network elements B to G are arranged in the ring. 16 x STM-1 signals, e.g. from a central internet server, are fed into the central network element A of the ring, in which the data ~~are~~ ^{is} transmitted ~~by means of~~ ^{via} a synchronous transfer mode STM. In the central network element A, the data ~~are~~ ^{is} fed into the ring both in the clockwise direction as working signals W on a working path WW and in the counterclockwise direction as protection signals P in a protection path PW. The working path WW is represented by a solid line and the protection path PW is represented by a broken line.

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In the event of an interruption in the ring, e.g. between the network element C and the network element D, the network elements B and C continue to be reached via the working path. The network elements D to G, ~~in~~ ^{by} contrast, are supplied with the protection signals P.

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The protection method used is a subnetwork connection protection SNCP method, also referred to as path protection method. This method is suitable, in particular, in the case of data traffic directed one-way, since it offers the same transmission capacity in the ring as a shared ring protection method. In this method, the control of the working and protection signals is simple to ~~realise~~ ^{achieve} since there is no need for any changeover protocols for a changeover in the network elements. The changeover in the network elements is, in each case, effected at the receiving end on the basis of local information.

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Figure 2 illustrates the data paths within the ring according to the ^{Present} invention. The working path WWR, WWL is represented by a solid line and the protection path PWR, PWL is represented by a broken line. In the case of the method ^{of} ~~according to~~ the ^{Present} invention, the ring is logically subdivided into two ring halves, proceeding from the network element A. 32 x STM-1 signals are fed into the ring by the central network element A, which ~~can~~ ^{can} also be referred to as gateway node A. In this case, 16 x STM-1 signals are fed into the ring as working signals WR on the working path WWR in the clockwise direction and 16 x STM-1 signals are fed into the ring as working signals WL on the working path WWL in the counterclockwise direction. ~~In the case of the method according to the invention,~~ ^{According to the method of the Present} the protection signals PR, PL are transmitted on separate paths from the central network node A to the terminating network element pair D, E, between which the first and second parts of the ring adjoin one another. In the figure shown, the logical separating point of the ring subdivided into two ring halves is between the terminating network elements D and E. In the clockwise direction, data fed into the ring ~~are~~ ^{is} forwarded in the left-hand ring half and, respectively, first part of the ring in the counterclockwise direction as protection signals past the network elements G and F as far as the network element E. Only in the terminating network element E are the protection signals fed into the ring and run in the opposite direction to the working signals in the right-hand ring half and, respectively, into the second part of the ring to the central network node A. The same procedure is effected with the data fed into the left-hand ring half and, respectively, into the first part of the ring. In this case, the protection signals are fed past the network elements B and C and selected only at the terminating network element D and fed into the terminating network element E into the right-hand ring half and run in

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the opposite transmission direction in the left-hand ring half to the working signals transmitted in the left-hand ring half.

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A configuration of the central network node A is represented in ^{Figure}~~figure~~ 3. The core of the central network node A is formed by an add/drop multiplexer A/D-MUX, to which 32 x STM-1 signals are fed. The
5 add/drop multiplexer A/D-MUX is designed with a tributary connection T, a switching matrix KF and ~~also~~ optical STM-16 line interfaces East and West. The line, interfaces East and West output optical signals, formed, for example, by selective lasers with specific
10 wavelengths λ_1 and λ_2 . There are arranged at the line interfaces East and West, in each case in series, an optical splitter OSO, OSW and an optical filter OFO, OFW. In the optical splitter OSO, the optical signal λ_1 is split into working signals λ_1WL and into protection signals λ_1PL . In the optical splitter OSW connected to
15 the line interface West, the optical signal λ_2 is split into working signals λ_2WR and protection signals λ_2PR .

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Downstream of the line interface East, in the optical filter OFO, the working signals λ_1WL of the
20 line interface East and the protection signals λ_2PR formed in the optical splitter OSW at the line interface West are added and form an optical signal λ_1WL and λ_2PR . An optical signal λ_2WR and λ_1PL is formed by the optical filter OFW in a corresponding
25 manner in the opposite direction.

The working and protection signals λ_1WL , λ_2PR and λ_2WR , λ_1PL , respectively, are in each case forwarded to the nearest network elements G, F, E and B, C, D, respectively.

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30 At both optical filters OFO, OFW ~~there is~~, however, ^{there is} also the possibility of selecting a desired optical signal.

35 Instead of the optical filters OFO, OFW, it is also possible to use wavelength division multiplexers WDM. Protection signals and upstream signals pass to the line interfaces East and West from the respectively following network elements.

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Figure 4 shows a configuration of the network elements B, C, F and G of the ring. An optical filter OF or a wavelength division demultiplexer WDM/D; wavelength division multiplexer WDM/M in the network elements F and G in the left-hand ring half taps off from the optical signal λ_{1WL} , λ_{2PR} the working signal λ_{1WL} and allows the protection signal λ_{2PR} to pass. Likewise, the protection signal λ_{1PL} in the optical filters OF of the network elements B, C in the right-hand ring half are fed past the network elements B, C in the right-hand ring half.

At the line interface West, the working signal λ_{1WL} is fed to the add/drop multiplexer A/D-MUX, and through the switching matrix KF, signals intended for subscriber TL connected to this network element are coupled out and passed on to the subscriber TL via a tributary connection T.

Portions of the working signal λ_{1WL} that are to be forwarded are coupled via the line interface East once again ^{v.i.a} ~~by means of~~ the optical filter OF into the data stream on the working path WWL of the ring, so that an optical signal λ_{1WL} and λ_{2PR} is once again produced. In the opposite direction, at the line interface East, in this case, the protection and upstream signals can be applied to the A/D MUX. In the right-hand half of the ring, ^{v.i.a} ~~by means of~~ the same procedure, a specific signal for a subscriber in the network elements B, C is coupled out, ~~and~~ the remainder of the working signal is coupled in again and protection and upstream signals are forwarded.

Figure 5 shows a configuration of the terminating network elements D and E which respectively terminate one half of the ring network. With the aid of an optical filter OF or a wavelength division demultiplexer WDM/D, the working signal λ_{1WL} is coupled out from the terminating network element E and fed to a line interface East of the terminating network element E. The protection signal λ_{2PR} is fed, if appropriate, via an optical amplifier OA to the

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line interface East of the terminating network element
D. Via the switching

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matrix KF of the terminating network element D and the line interface West of the terminating network element D, the protection signals $\lambda 2PR$ previously forwarded on to the auxiliary protection path HPWR in the left-hand half of the ring pass into the protection path PWR of the right-hand half R of the ring network RN. The protection signals $\lambda 1PL$ which were previously forwarded on the auxiliary protection path HPWL in the right-hand half R of the ring network RN pass via the line interface West, the switching matrix KF and via the line interface East into the protection path PWL of the left-hand half L of the ring network.

Figure 6 shows a further configuration of the network elements D and E which respectively terminate one half of the ring network. This configuration differs from that shown in ~~figure~~ ^{Figure} 5 by virtue of the fact that data ^{is} ~~are~~ sent from a subscribers TL connected to these network elements to other network elements or to the central network element A within the left-hand or right-hand half of the ring. In a departure from the illustration from ~~Figure~~ ^{Figure} 5, the protection signal $\lambda 2PR$ is fed from the optical filter OF via a tributary connection to the switching matrix KF of the network element E. The protection upstream data transport is likewise fed in the switching matrix KF. Between the line interfaces East of the network element D and the line interface West of the network element E, the aggregate signal formed from protection signal $\lambda 2PR$ and protection upstream signal, and also the aggregate signal formed from the protection signal $\lambda 1PL$ and protection upstream signal, are output. The upstream data stream in the ring correspondingly reduces the capacity of the data fed into the central network element A.

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